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Principles for the socially responsible use of conservation monitoring technology and data

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Abstract

Wildlife conservation and research benefits enormously from automated and interconnected monitoring tools. Some of these tools, such as drones, remote cameras, and social media, can collect data on humans, either accidentally or deliberately. They can therefore be thought of as conservation surveillance technologies (CSTs). There is increasing evidence that CSTs, and the data they yield, can have both positive and negative impacts on people, raising ethical questions about how to use them responsibly. CST use may accelerate because of the COVID-19 pandemic, adding urgency to addressing these ethical challenges. We propose a provisional set of principles for the responsible use of such tools and their data: (a) recognize and acknowledge CSTs can have social impacts; (b) deploy CSTs based on necessity and proportionality relative to the conservation problem; (c) evaluate all potential impacts of CSTs on people; (d) engage with and seek consent from people who may be observed and/or affected by CSTs; (e) build transparency and accountability into CST use; (f) respect peoples' rights and vulnerabilities; and (g) protect data in order to safeguard privacy. These principles require testing and could conceivably benefit conservation efforts, especially through inclusion of people likely to be affected by CSTs.

KEYWORDS

conservation surveillance technology, camera trap, drone, ethics, monitoring, social responsibility, surveillance, technology, unmanned aerial vehicle

1 | INTRODUCTION

Automated monitoring technologies are revolutionizing conservation science (Adams, 2019). Unmanned aerial vehicles, satellite sensors, remote cameras, and audio sensors yield insights for research and management that are qualitatively and quantitatively different from either direct human observation or most remotely-sensed data (Arts, van der Wal, & Adams, 2015). Social media platforms too, including wildlife-specific ones such as eMammal and Wildlife Insights, but also general platforms like Instagram or Twitter, provide unparalleled

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information about wildlife and human activities, with direct relevance to many dimensions of conservation management (Toivonen et al., 2019). Sensing devices are increasingly automated and interconnected, allowing increasingly-detailed profiling of an animal or a human subject (Zuboff, 2018). These developments are exciting for conservation but do raise questions about social and political impacts because some devices can monitor people as well as non-human wildlife (Resnik & Elliott, 2019). Whether or not human monitoring is deliberate, devices gathering such data can be considered a form of conservation surveillance, defined by Sandbrook, Luque-Lora, and Adams (2018) as "close watch kept over someone or something for conservation purposes" (p. 494). So far, literature on the ethical dimensions of these technologies in conservation has understandably focused on minimizing impacts to wildlife themselves (Gibeau & McTavish, 2009; Hodgson & Koh, 2016; Rebolo-Ifrán, Grilli, & Lambertucci, 2019) but has generally paid insufficient attention to potential impacts on people. An important exception is the growing literature on "community drones", which chronicles, analyzes, and promotes grassroots utilization of drones for environmental and social justice (Paneque-Gálvez, Vargas-Ramírez, Napoletano, & Cummings, 2017; Radjawali & Pye, 2017; Radjawali, Pye, & Flitner, 2017; Vargas-Ramírez & Paneque-Gálvez, 2019). Most recently, Sharma et al. (2020) recommended a set of practices for ethical use of camera-traps. Importantly though, all these studies have been limited to single technologies for field deployment and do not specifically examine their broader implications for conservation practice.

Outside the conservation field, there is a lively and important public discourse about the social implications of surveillance both by state and private actors (Australian Human Rights Commission, 2019; Bernholz, Ozer, Wainscott, & Elhai, 2020; Internet Governance Forum, 2019; Zook et al., 2017; Zuboff, 2018). Legal provisions now often dictate—with varying strength—the circumstances under which: (a) people may be identified (e.g., using facial-recognition software or geotags of home location); (b) data from different sources may be combined (e.g., mobile devices, surveillance cameras, till receipts); and (c) data may be stored, sold and used (Choudry, 2019; Zuboff, 2018). Similarly, other analytical fields using similar data sources have developed their own principles for data collection and management to avoid harming people (Zook et al., 2017).

However, with the exception of Sharma et al. (2020) on camera traps, no such principles have yet been developed for the particular case of wildlife conservation and we believe they should be, as has been urged for artificial intelligence in conservation (Galaz, 2015; Wearn, Freeman, & Jacoby, 2019). There are manifold ways that data on peoples' spatial and temporal activities—plus their identities—can be collected, aggregated, and rendered into actionable information with or without their knowledge or consent, using what we call here conservation surveillance technologies (CSTs). We acknowledge that the word "surveillance" can be perceived as pejorative. This is not our intention in using it. Rather, we do so to differentiate CSTs from other widespread monitoring technologies which cannot collect comparable information about people (e.g., telemetry transmitters) and in order to highlight connections to existing scholarship on surveillance in other contexts. The potential for societal impact exists in at least two circumstances: first, where the intent is to detect, track, and monitor people, and second, where the intent is to observe non-human animals or landscapes but people are incidentally observed as "bycatch" (Sandbrook et al., 2018; Shrestha & Lapeyre, 2018). Issues also arise both "in the field" as traditionally understood, and through online surveillance and big data science as content and location data about social media users is often collected and used without users knowing about it (Toivonen et al., 2019).

This paper identifies a preliminary set of principles for the socially responsible use of conservation surveillance technology and data (Figure 1). These principles are based on the authors' collective experience using CSTs for research (Clark et al., 2018), facilitating CST development, studying the ethical issues around CSTs (Adams, 2019; Sandbrook, 2015; Sandbrook et al., 2018) and using user-generated content to study human-nature interactions (Di Minin, Tenkanen, & Toivonen, 2015; Hausmann et al., 2018; Toivonen et al., 2019). In contrast to previous studies that have made recommendations for the appropriate use of single technologies (Duffy et al., 2018; Sharma et al., 2020), we aim to provide a "full spectrum" view which can be applied to all existing and new conservation surveillance technologies, from social media posts (Toivonen et al., 2019) to satellites (Lynch, Maslin, Balzter, & Sweeting, 2017). Our intention is to advance a provisional set of empirical but forward looking, constructive, and pragmatic principles for the use of surveillance technologies and their data for conservation. We invite real-world testing, elaboration, and development of our ideas.

We developed these principles through a four-stage process. First, each author generated draft lists independently. We then held a one-day workshop to collate the lists, discuss overlaps and omissions, and identify a final list. Third, we developed text for each principle collectively using a shared file online. Finally, we sought feedback from CST users on Wildlabs.net, an international online forum on conservation technology, by posting a summary of our principles (see Supporting Information) for the "Ethics of Conservation Tech" group on the Wildlabs.net platform and inviting comments across multiple Wildlabs

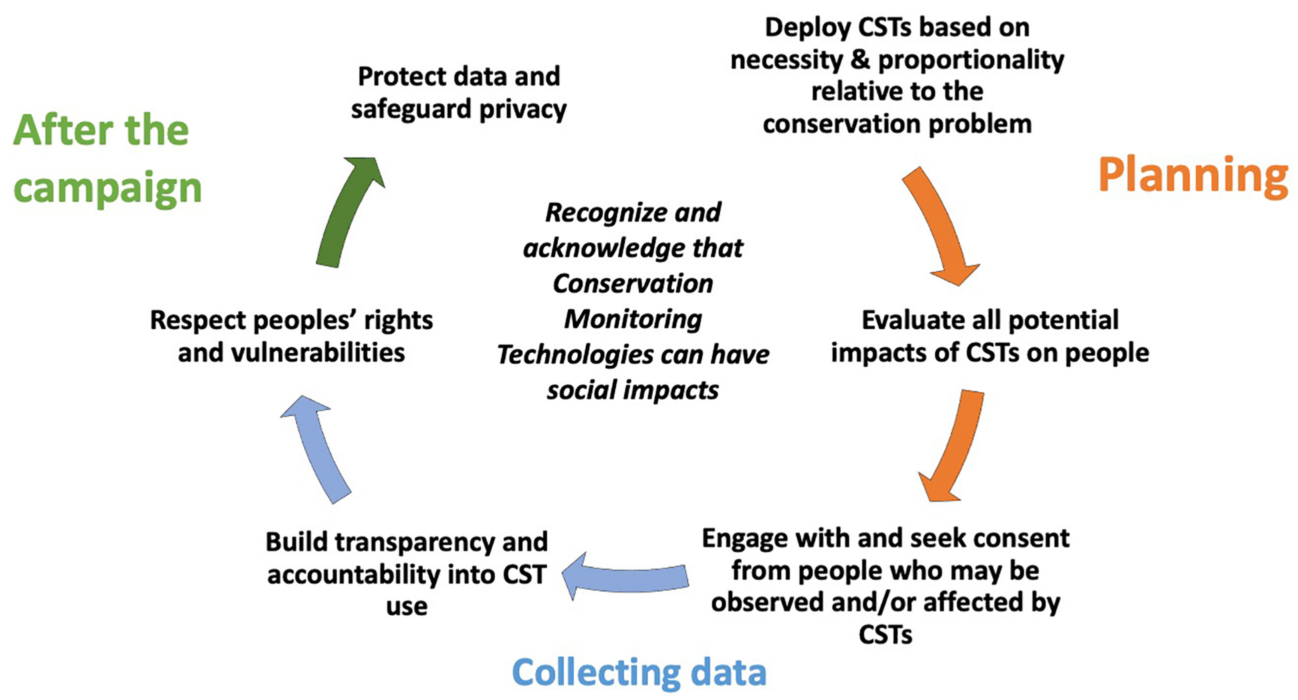

FIGURE 1 The seven principles for responsible CST use and their relationships with different stages of deployment

groups and on Twitter (https://wildlabs.net/community/thread/907) from June 04–15, 2020.

2 | PRINCIPLES FOR THE SOCIALLY RESPONSIBLE USE OF CONSERVATION MONITORING TECHNOLOGY AND DATA

2.1 | Recognize and acknowledge that CSTs can have social impacts

As discussed above, the use of conservation surveillance technologies can affect the lives of people in various ways, both positively and negatively; and deliberately or inadvertently. Social impacts are worthy of consideration in their own right, and they might have downstream effects on conservation outcomes if they change attitudes and behaviors toward conservation. However, social issues raised by CSTs are rarely discussed in either the academic literature (Sandbrook et al., 2018) or practical guidance for technology users (Wearn & Glover-Kapfer, 2017). *Recognition* and *acknowledgement* that the use of CSTs may have social impacts are critical first steps toward their responsible use. Figure 2 shows a set of example questions that CST users can ask themselves about their own work to start that reflective process and identify where they may need to take further specific action, based on the remaining principles.

2.2 | Deploy CSTs based on necessity and proportionality relative to the conservation problem

Proportionality and necessity are longstanding, closely related, and complementary concepts from international human rights law, for example the UN Universal Declaration of Human Rights (UNDHR, 1948), the United Nations' Declaration on the Rights of Indigenous Peoples (UNDRIP, 2007), as well as in the domestic law of many countries. Together they provide the boundaries around what kinds of CST use should be acceptable in any given context. The principle of *proportionality* holds that the use of CSTs must be proportionate to the benefits arising from their use. The principle of *necessity* holds that a certain technology should only be used, or certain data should only be collected and processed, where there is no alternative, less intrusive means of pursuing the goal.

Fundamentally, these principles are concerned with achieving a proper balance between the rights and interests of those who wish to deploy CSTs for a certain purpose and the rights and interests of those likely to be affected by their deployment. They are also key principles of data protection, privacy, and surveillance laws in many jurisdictions. For example, balancing necessity and proportionality is a core principle in the UK Home Office's *Surveillance Camera Code of Practice* (, 2013). The Council of Europe's European Convention on Human Rights (now incorporated into the domestic law of most

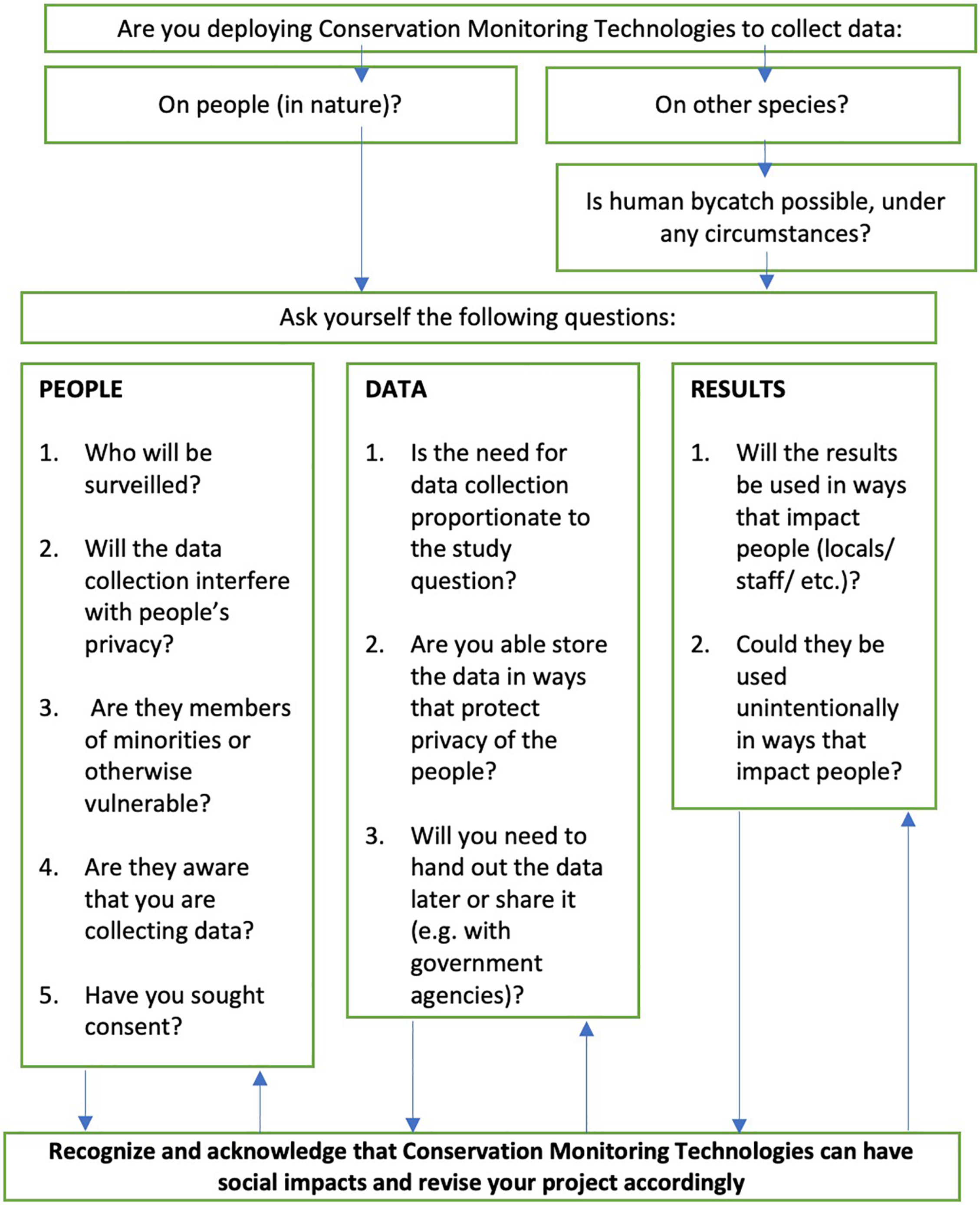

FIGURE 2 Process flowchart for CST users to determine ways they can apply the responsible use principles in their planned CST deployments

European countries) states that interferences with the right to privacy are only permitted where they are necessary in a democratic society on a limited number of grounds. Accordingly, the European Court of Human Rights has repeatedly found that an interference with the right to privacy under the Convention for the purposes of surveillance must be necessary and proportionate—it must meet a "pressing social need" that cannot be met by alternative means. Similarly, the EU's Charter of Fundamental Rights states that limitations on rights and freedoms must be subject to the principle of proportionality and made only if they are necessary and genuinely meet a general societal need or the need to protect the rights and freedoms of others. In the EU, the General Data Protection Regulation (GDPR) further holds the principles of proportionality and necessity as fundamental in relation to the processing of personal data.

To ensure that a particular CST use is proportionate and necessary requires clear definition of purpose (rather than speculative deployment), demonstration that their use is the least intrusive means to achieve this purpose, and an explicit consideration of the balance of likely benefits against any possible harm to the rights and interests of people likely to be affected. However, a qualitatively unique ethical challenge that conservation faces, which other human-focused surveillance venues do not, is balancing threats to non-human nature against human rights. Environmental protection laws exist to provide societies with authoritative frameworks for making such determinations, and to demarcate the limits of permissible infringements of rights to achieve environmental objectives. CST users must obey such laws. However, ethical concerns may go further since laws typically do not cover every foreseeable circumstance, and laws may allow deployment in ways that contribute to marginalization or oppression of specific groups (below).

The nature of what is necessary and proportionate should be assessed holistically in light of specific circumstances: the more serious the problem, the greater the likelihood that the use of CSTs would be necessary and proportionate. At all times the rights and interests of those likely to be affected by surveillance should be borne in mind in determining whether the use of CSTs—and the accompanying potential for interference with those rights and interests—is proportionate. For relatively minor issues, it may be the case that only very minimal application of CSTs is appropriate; in a genuine crisis, more extensive surveillance may be justifiable. Saturating a protected area with cameras, microphones, or sensors, for instance, is unlikely to be a proportionate approach in all but the most extreme circumstances. Again though, declarations of conservation crisis are political acts based on values that are invariably contested but not always scientifically supported (Chan, 2008). Conservationists deploying CSTs should also be aware of the risk of surveillance creep, where CSTs deployed for one purpose may end up being used for others (Sandbrook et al., 2018). Moreover, when repurposing CSTs the same proportionality and necessity assessments should be undertaken as for initial deployment. Understandably, many conservationists will weigh against this consideration the potential for unanticipated but biologically significant findings as a study progresses: for example, documenting unexpected species (Clark et al., 2018). Circumstances matter for making such decisions, as does local engagement (below).

2.3 | Evaluate all potential impacts of CSTs on people

Assessment of the potential impacts of CSTs on people can draw on existing in-house research protocols (e.g., mandatory ethics review or social impact assessment [SIA] processes). These review bodies require sufficient information to be able to do their job well: typically the more specific, relevant information they receive, the better. Where in-house processes are not available we encourage CST users to request that they be established, and in the meantime to make use of online guidance such as the SIA hub or the UK Economic and Social Research Council ethics guidance. SIA methodology, commonly used with project interventions such as infrastructure development, would also be relevant (Takyi, 2014). If users do not feel competent to carry out such an assessment they should seek the support of somebody who does. It is advisable to take a little more time to get this step right than to rush into deploying CSTs in a way that may lead to ethical problems arising. Deciding not to proceed with the deployment of CSTs should always be a potential outcome.

Impact assessments should consider both who might benefit and who might be harmed by CST use, and how these outcomes might be distributed within the population of those affected. Are there particular groups of people who might be affected more than others? For example, it may be that most people are supportive of CST use, but a minority group might be at risk of harm and therefore not supportive. Users should consider all dimensions of social difference in this analysis: for example there is emerging evidence from India that camera traps can be more harmful to women than men (Simlai, unpublished data). Is there any history of conflict or social unrest in the area in which CSTs are to be deployed, particularly relating to conservation? If people perceive themselves as victims of a historical injustice related to conservation (e.g., being evicted from or losing access to an area) then they may be particularly likely to react negatively to surveillance. There is also an increased likelihood of conflict if the CSTs are intentionally targeted at people, such as for anti-poaching (even if some local people are supportive).

Another group to consider is the people who will be involved in using CSTs. While CSTs can improve staff wellbeing (for example by reducing the risk of encountering armed hunters whilst out on patrol [Critchlow et al., 2017]) there is some evidence that workplace surveillance associated with carrying tracking devices can be psychologically distressing for conservation staff, and even expose them to more risk (Simlai, unpublished data). Finally, CST users must consider any possible risks to themselves and any local partners since even the use of CSTs for scientific purposes can arouse suspicion from governments (Stone, 2018).

2.4 | Engage with and seek consent from people who may be observed and/or affected by CSTs

In most cases a fundamental initial component of such engagement will be obtaining the free, prior, informed, and ongoing consent of those who may be observed. While some exceptions exist (e.g., law enforcement), conservation applications of CSTs without consent should be considered ethically questionable. In the extreme that could jeopardize an initiative and/or even expose those deploying CTSs to legal sanction. Browne and Ljubicic (2019) accurately observe that there is no simple formula for obtaining consent since levels of consent can vary and distinctions often exist between individual and collective (i.e., community) consent may exist and should be followed (e.g., national park use permits, research agreements with communities, contracts, research permits). In some situations even knowing who has the authority to grant consent may not be clear. We do not claim to have ready solutions to the many challenges of obtaining consent. Nonetheless, working from a set of principles such as these could help build trust, obtain consent, and open up possibilities for engagement. We encourage conservationists to try, while documenting and sharing what they learn.

Informed consent by members of the public becomes especially important in the case of social media platforms, whose users usually give consent when they sign in but are rarely aware that they have done so or what that means (Zuboff, 2018). A person's decision to share data online is not the same as giving consent for its use by a third party and their user communities. Consequently they need to be able to fully and easily inform themselves about the multiple potential uses and interests their voluntarily-contributed data will serve. User guidelines for Wildlife Insights, for example, clearly indicate to participants that camera trap photos will become public domain after 2 years (or an embargo period) and that the initiative's partners will use those images and associated metadata in global conservation assessments (https://www.wildlifeinsights.org/faq). Users, of course, need to be able to access and read such guidelines in their entirety and not simply click "I agree" to avoid cumbersome opt-out processes (Zuboff, 2018). Ideally, platforms should invite users to consciously and voluntarily contribute their data for research. Not all users will want to lose control of the uses of their data: Indigenous peoples in particular might prefer to engage with platforms built to address users' legitimate needs for privacy and self-determination. For example, users of the Inuit-developed SIKU app (http://siku.org) can share many types of environmental observations while retaining full ownership, control, access, and possession of their own data.

Meaningful engagement differs from consent and adds demonstrable value to conservation efforts, for example, through novel insights from shared local knowledge, increased local support, and reduced likelihood of equipment vandalism. Conservationists using CSTs should examine the potential for community engagement early, and then work within their local context to identify shared interests and build productive relationships over time. For example, Cummings et al. (2017) worked closely with Indigenous communities in Guyana to build and deploy drones for mapping agricultural plot conditions in their traditional territories. Active community involvement throughout that project enabled those communities to direct technological capabilities toward their own cultural and livelihood needs. Elsewhere, the Raincoast Conservation Foundation collaborated with the Heiltsuk First Nation to describe novel patterns of grizzly bear (*Ursus arctos*) habitat and space use by integrating traditional knowledge with camera trap data and genetic analyses (Housty et al., 2014; Service et al., 2014).

2.5 | Build transparency and accountability into CST use

This principle applies to conservationists' interactions with anyone who may have data collected about them by a CST. We suggest clear communication with those who may be observed regarding how data is collected and stored, who uses it (including third parties and government agencies), for what purposes, and why it is needed. Ongoing consistency and transparency about the extent of potential uses to which CST data may be put is important. In other words, do not start using social data for a different purpose than what was discussed and agreed with potentially surveilled people. Those working with pre-existing CST data that may not have been collected or stored with these considerations in mind should try to determine if what has been done was justifiable, and if so how to limit potential for harm going forward. Ongoing monitoring and revision of CST deployments can not only help optimize efforts but also signals intent. Monitoring CSTs' effects makes it clear to those potentially affected that CST users are paying attention, being responsive, and can be trusted to end the effort when their goals are met. Monitoring should be designed around the potential impacts identified in advance (see Principle 3), while also being responsive to unanticipated impacts.

One simple proactive step that can alleviate mistrust is to make contact information publicly available to anyone with questions or concerns about CSTs. Signs at entry points into areas where CSTs are deployed, and posters in nearby public places, are also good practices. Those signs can be in multiple languages and need not specify the exact location of every device. Infrastructure on the ground (e.g., camera traps) should be clearly and permanently marked with the deploying organization's name and phone number or email address (Figure 3).

The relationship between CSTs and conservation law enforcement needs specific examination because CST

FIGURE 3 Trail camera housing with organization's name, contact information, and purpose clearly and permanently marked. Photo: Matt Webb, Parks Canada

data are an easily-obtained potential catalyst for human rights violations; intentional or otherwise. Conservation enforcement efforts, including the collection and use of CST data, must be legitimate, humane, based on societal consent, and cannot be practiced selectively on different groups of people (Springer 2011). Concern about CST users' understanding of such principles is justified. Sandbrook et al. (2018) found that over 50% of camera trap researchers with photos of illegal activity had handed them over to authorities for conservation enforcement, even though the majority of those deployments were not intended to even detect people in the first place. It is not possible to second-guess how justifiable those situations were, but the same study found that only 27% of participants had a plan in place beforehand to deal with such ethically-challenging situations. More such deliberate forethought is what we advocate here.

2.6 | Respect peoples' rights and vulnerabilities

Certain groups of people are particularly vulnerable to CST surveillance and so require particular care by CST users. The necessity of protecting human rights is recognized worldwide not just in countries' domestic laws but in international agreements such as the UNDHR, UNDRIP, and, less formally, the Conservation Initiative for Human Rights declaration (Springer, Campese, & Painter, 2011). Surveillance's known effects on rights and vulnerabilities include discouraging dissent or participation in social movements (Cunnigham & Noakes, 2008), impacting civil liberties (Lyon, 2001), and enabling mobility of certain privileged groups over others (Graham & Wood, 2003).

CSTs therefore risk reinforcing social inequalities and hierarchies along the lines of gender, class, and race (Coleman & Mccahill, 2011). Before deploying CSTs it is important to consider such vulnerabilities in their local context, including customs and traditions. For example, in the forests of North India women are the primary collectors of non-timber forest produce. They often come in contact with camera traps, making them more vulnerable than men. While going about their daily activities they could be automatically photographed in ways that are culturally unacceptable, affecting their emotional and psychological wellbeing. Moreover, womens' concerns may be difficult to hear since most village consultations for conservation interventions are poorly attended by women. This is due to deeply entrenched patriarchy and societal expectations of what qualifies as "men's" work and "women's" work reinforcing patterns of gendered vulnerability (Ogra, 2008).

Many areas of conservation importance in the global south overlap with areas of human use. For example, local communities living in fringe villages of protected areas often use these areas for their daily sanitary needs. Studies have shown that sloth bear attacks in India happened most frequently when victims used forests and scrubs for open defecation (Debata, Swain, Sahu, & Palei, 2017). The use of CSTs in areas used by people for relieving themselves might contribute to additional stress on people by making them change their preferred locations, leading to potentially increased risk of conflicts with wildlife (Simlai, unpublished data).

Infringement of rights through CST data collection may be perceived to be justified by conservation imperatives, but—as discussed—that cannot be assumed. Conservation law enforcement may legitimately require surveillance of people, with or even without their knowledge or consent. We do not dispute that need. Nonetheless, we recommend that the legitimacy and legality of such applications be clearly established beforehand in order to retain public trust in conservation authorities and, for third parties using such data, avoid the possibility of legal action or other negative consequences.

2.7 | Protect data in order to safeguard privacy

Many jurisdictions will have data protection and privacy laws that should be complied with in full at all times. However, not all countries' laws provide the same level of protection to individuals so laws should be thought of as providing a minimum standard, not a target. We therefore suggest that conservation researchers should seek to develop common rules for data management; not just those that have been legislated for in the country in which CSTs are to be deployed, but a set of principles that are supported by the broader scientific community and stakeholders. This would mean that even in countries that have no or inadequate data protection or privacy laws a set of good practices for data collection and processing should be followed in the design, deployment, and use of CSTs. Although we do not seek to prescribe a definitive standard we suggest some minimum standards for best practice.

Responsible data handling practices are essential for protecting privacy and fostering trust with local communities. The Ownership, Control, Access, Possession (OCAP) framework provides an instructive set of data management principles developed by Indigenous peoples in Canada (Schnarch, 2004). Data protection laws such as the GDPR also provide a solid framework on which to base data handling practices. Only collecting data that is necessary for the purpose, storing it only as long as it is required, timely deletion of data that is no longer needed, and using state of the art security techniques—such as encryption and organizational measures to ensure data security—are essential. It may be possible to automate good practice, such as by anonymizing data on-the-fly (although true anonymization is difficult to achieve, so even "anonymized" data must be managed responsibly), aggregating data instead of maintaining sets of individually identifiable data, or automating the deletion of human images. Where data have been aggregated, raw individual data should be deleted. Data from social networking sites should not be collected unless it is necessary, due to the potentially sensitive nature of this information and to reduce the potential for ethical dilemmas. If possible, all data should be automatically deleted once it is no longer needed.

Data sharing and reuse require particular care. To maintain the trust of people potentially affected by CSTs, it is important not to sell the data collected (whether for commercial or other purposes) or to re-use it for any purpose incompatible with that for which it was collected. Moreover, non-state conservation researchers and practitioners using CSTs should not make a practice of giving data about people to governments unless by prior legitimate agreement, when complying with a legal warrant, or in extreme situations such as imminent threat to human life. Data sharing agreements with governments may be a condition for receiving approval to deploy CSTs. Such agreements (even where not strictly required) can be useful to clarify what will be used, what will not be, and for what purposes. Ideally, data sharing agreements should allow researchers to retain ownership of data, incorporate protections against misuse, and prohibit the use of data by law enforcement agencies. Nevertheless, it is important to be careful—such agreements often result in all data belonging to the state, which can then use it how it likes. Under-resourced conservation agencies might well benefit from such data but handing it over to authoritarian or oppressive regimes would be problematic, and rising nationalism may even mean that data sharing poses a particular risk to ethnic minority groups. If CSTs are being deployed in a HWC-mitigation context it may be desirable to share data in real-time with local people who may be affected. Such sharing should be evaluated for potential societal impact and, if necessary, steps taken to aggregate and anonymize human data as far as possible.

Citizen science platforms are used intentionally and usually with consent. Social media posts on the other hand, are usually shared primarily with followers or friends in mind. Most users are not aware of the programming interfaces that some social media platforms provide for data analysts. Nor do users typically know that "web scraping" as a data collection method is allowed under US law, so that any data posted on webpages can be collected computationally. Conservationists using social media data must apply high ethical standards even if people have posted such data voluntarily. While detailed personal information can be derived from the individuals by mining their profile information, social network and post history (including all textual and image content, likes, post contents and geotags and timestamps of the posts), researchers should be extremely considerate when doing so (Toivonen et al., 2019; Zook et al., 2017). Unnecessary data fields should not be collected or stored at all, all data should be stored in pseudonymized data bases separating the user information from the rest, and analysis results should never be presented so that individuals may be identified (Fink & Di Minin, 2018). CST deployments intending to record questionable or illegal activities should pay particular attention to these points. Broader societal questions about surveillance are also germane here. For example, geotags may be blurred or other metadata may be stripped from posts so that the public does not access that information, but the companies still store the data store and may sell it: all without broader knowledge they are doing so. Perversely, warning users may lead to less meaningful content from a conservation perspective if users start self-limiting relevant postings.

Increasing attention to transparency, reproducibility, and overall openness of scientific results means that journals and funders oblige storage of the original research data to data repositories upon publication or project completion. These developments in scientific practices are of paramount importance but also highlight the need for increasingly professional data management. As data collected by CSTs are archived to open access data repositories and stored for years or decades, researchers need to consider also future scenarios for potential misuse of data, for example, in the case of emerging land use or political conflicts, particularly from the viewpoint of human bycatch. We strongly advise that CST data sets are cleaned of any unneeded elements as early in analysis as possible.

3 | DISCUSSION

Conservation surveillance technologies are likely to proliferate and evolve. They will continue to benefit conservation practice and research worldwide while also posing challenges that we believe are mitigable by applying and testing the ethical principles presented here. Functionally, we call for promotion and adoption of standards for socially responsible surveillance by CST users which includes assessments of societal impacts, strong engagement with local conservation partners and stakeholders, and ongoing review of and improvement to these best-practice principles as technologies and conservation challenges change. Widespread dissemination of techniques and instruments for reducing the societal impacts of CSTs while improving their effectiveness for conservation will be particularly beneficial. Evaluating such effectiveness is not likely to be straightforward given the particular values-based tradeoffs between human rights and conservation in each different case, nor will such context-specific exercises necessarily produce generalizable results. We recommend paying particular attention to innovations in responsible CST use that could be effectively diffused and adapted elsewhere (Lynch & Brunner, 2007).

Our principles apply at all stages of the project cycle and to anyone deploying or using CSTs and the data they collect, which we take to include social media platforms. We present the principles ordered by the stage of deployment during which they need to be considered (pre-, during, post-). They apply in any context for designing, testing, deploying, and using CSTs in conservation, whether the intention is to collect data from people or not. How they might be applied will vary with the context and aims of a particular deployment: this paper's Supporting Information includes two hypothetical scenarios of CST based on composites of real situations that illustrate how our principles could be applied. Moreover, our principles are not necessarily an exhaustive or final set since new tools will likely continue to be developed and adapted for conservation, with potentially novel implications.

There are multiple reasons for caution when using CST data about people: the risk of erroneous conclusions from non-representative samples, potentially backfiring management actions, and lack of surveilled peoples' consent and awareness—especially of the extent and nature of social media data use. While social media or citizen science data-collection platforms may prove a useful data source for conservation, it is important to carefully consider the representation of the data. This is particularly important when basing managerial decisions on them. Observational data collected by individuals is generally biased to where people move about and what they are interested in, which may considerably impact the patterns of species observations collected by citizens (Geldmann et al., 2016). Analysis of human activities in nature based on social media also need to account for any biases in and between platforms. Analysis of Instagram users in South African national parks shows, for example, that younger people and women have tended to be overrepresented (Hausmann et al., 2018), whereas local men dominate in the Flickr platform posts in Finnish national parks (Väisänen, Heikinheimo, Hiippala, & Toivonen, in press). Social media data has been used to monitor species or related sentiments (Fink, Hausmann, & Di Minin, 2020), but *Homo sapiens* is usually the species with highest representation in the content (Väisänen et al., in press).

While there is an evident need for care with CST data and use, it would undervalue conservation practitioners' abilities if these principles were seen as simply a checklist of pitfalls to avoid. Indeed, the potential for CSTs to have positive societal effects should be actively and systematically explored since local conservation partners are very often able to deploy and maintain increasingly user-friendly CSTs themselves (Paneque-Gálvez et al., 2017; Radjawali & Pye, 2017). Benefits from engaging local people in conservation practice and research can be substantial for people—as well as nature—by advancing locally-beneficial societal goals such as innovation, entrepreneurship, and self-determination (Nature Editorial, 2018). Realizing such benefits though depends critically on communicating with the people who will be observed by CSTs. In the field, this means moving not just to a "citizen-science" model where volunteers collect data for studies designed by scientists but toward "community science," in which communities make deliberate choices to engage with scientists toward mutually-determined objectives, co-producing new knowledge (Charles, Loucks, Berkes, & Armitage, 2020; Vargas-Ramírez & Paneque-Gálvez, 2019).

The present Covid-19 pandemic may well accelerate CST use, especially if international travel remains restricted. The benefits and risks of CSTs will both likely be amplified but these developments do not imply uniformly negative impacts from CSTs: indeed, they are poised to do considerable good during a time of great need (Evans et al., 2020). Parks and high-use natural areas were initially closed worldwide to prevent inadvertent person-to-person SARS-CoV2 transmission (e.g., https://www.cbc.ca/news/canada/calgary/parks-canada-closing-parks-to-visitors-covid-19-pandemic-1.5508233) and CSTs may be deployed to monitor and enforce such emergency closures. Concern about increased wildlife poaching is also growing as government and tourism-based revenues that fund anti-poaching efforts fall (Evans et al., 2020). Genomic data can be efficiently collected from environmental samples and is already being employed for zoonotic disease surveillance (Himsworth et al., 2020), opening up yet another avenue for collection of data about individual people that will require ethical management. Consequently the need to consider societal impacts of CSTs before and as they are deployed may take on more urgency.

We are genuinely excited about the prospects for CSTs and the insights gained from their unparalleled data-generating capabilities to advance conservation practice and research. Conservation efforts worldwide will ultimately benefit from more informed and ethical use of conservation surveillance technologies, both in times of crisis and otherwise. Indeed, the process of learning how to use them responsibly has considerable potential to qualitatively change our field for the better.

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CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

AUTHOR CONTRIBUTIONS

Chris Sandbrook led conceptualization, methodology, and resources; co-led investigation and project administration; supported writing- original draft and review and editing. Douglas Clark led writing- original draft and review and editing, co-led investigation and project administration; Tuuli Toivonen, Trishant Simlai, Stephanie O'Donnell, Jennifer Cobbe, and William Adams all supported the investigation and writing- review and editing; William Adams led funding acquisition, supported also by Tuuli Toivonen, Douglas Clark, and Chris Sandbrook.

DATA AVAILABILITY STATEMENT

No primary data were collected for this research.

ETHICS STATEMENT

No ethics approval was required for this research. The work was limited to literature review, discussion, and drawing from our own experiences.

TARGET AUDIENCE

This article is relevant to any users of conservation monitoring technology or data that could capture information about people, including social media data users.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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